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HRI Project 4424
Copy No._____

SAMPLING AND ANALYSES OF RICO-ARGENTINE CALCINE TAILINGS PONDS

for

Crystal Oil Company
P. O. Box 1101
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INTRODUCTION

For many years the Rico-Argentine property of Crystal Oil has roasted pyrite to produce sulfuric acid at Rico,Colorado. In this operation, a considerable quantity of calcines, which are predominantly iron oxides, have been accumulated in tailings ponds. In January of 1978, Crystal Oil authorized Hazen Research, Inc. to undertake a preliminary sampling program to determine the approximate quantity and quality of the calcine material in these tailings ponds.

Samples of the calcines were taken during the week of January 23, 1978, and the data concerning these samples are the subject of this report.

SUMMARY

At the request of Crystal Oil Company, Hazen Research has completed a preliminary sampling program on the materials contained in the Rico-Argentine tailings ponds.

The five tailings ponds contain approximately 234,000 tons of material with an average moisture content of 22.5 percent. The material is finely divided averaging over 35 percent of minus 400-mesh material.

The samples taken show a wide variation in chemical content with the upper layers containing up to 66 percent iron and as little as 8 percent acid insoluble material. These upper sections are also reasonably low in sulfur. The lower sections of the ponded material are much lower in iron content, and much higher in acid insol and sulfur. Although the tailings contain appreciable amounts of zinc and some lead, they are free of hazardous impurities such as arsenic.

The quality of the material in the upper sections of the ponds appears to be suitable for use as an iron additive in the cement industry.

SAMPLING PROCEDURE

On Monday, January 23, 1978, two people from Hazen Research, Inc. of Golden, Colorado, met with Orval Jenke of the Rico-Argentine Company in Rico, Colorado. The purpose of this trip was to sample the iron oxide tailings ponds on the Rico-Argentine properties.

There are two major and three minor ponds on the property, as shown in the sketch in Figure 1. Two holes were drilled in each of the major ponds and one in the only accessible minor pond. The other two ponds appeared to be less than three feet thick and were flooded by mine drainage, thus precluding any drilling. All dimensions are plus or minus 10 percent due to the three to four feet of snow which obliterated the actual boundaries. Sampling was done in five-foot intervals with a four-inch auger. The auger was drilled down five feet, rotation was stopped, and the aguer extracted from the hole. A four to six-pound sample was then taken from the material retained on the auger flights.

Tables 1 and 2 list the information obtained from these holes.

Sketch of Rico-Argentine Tailings Ponds

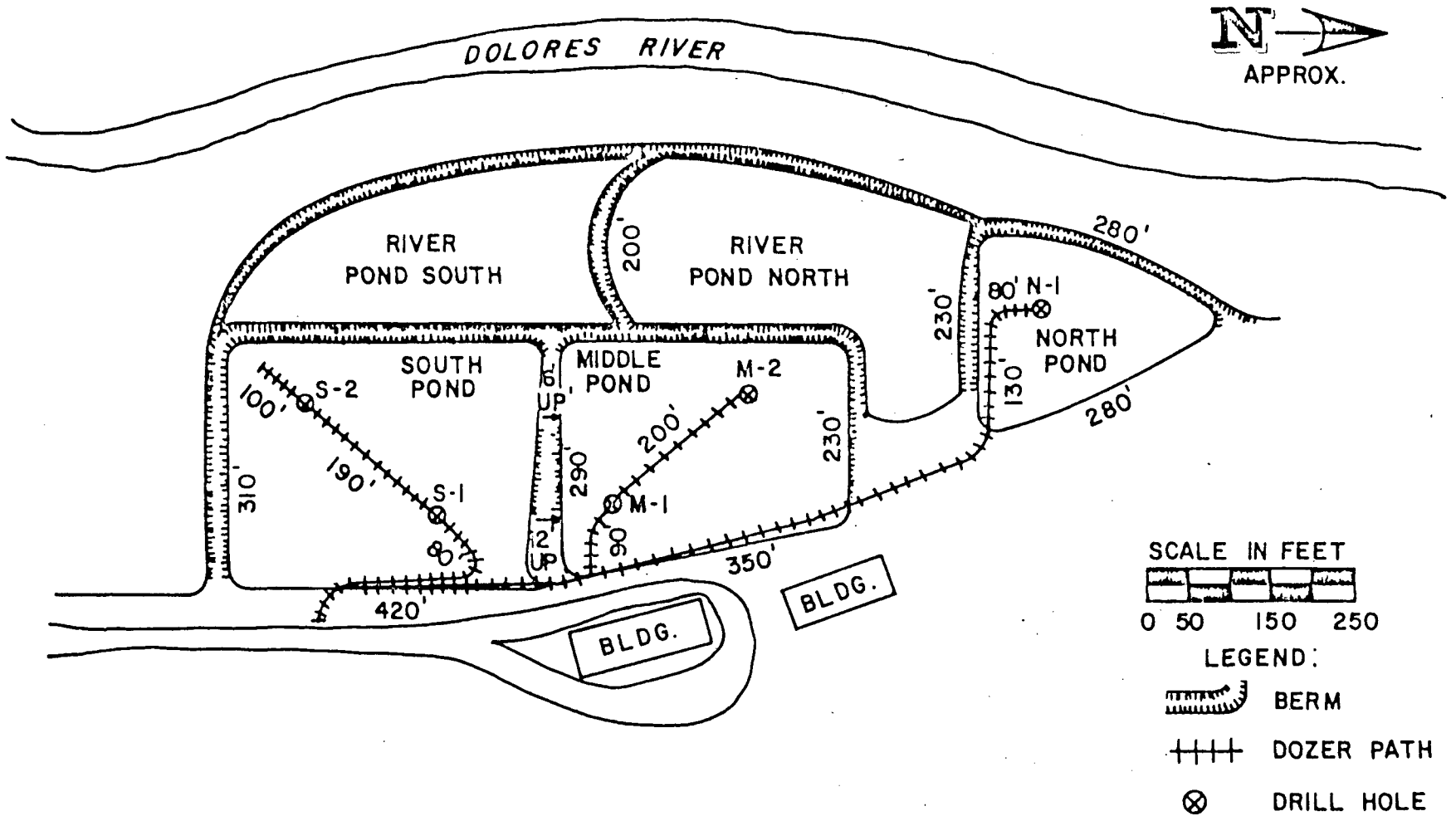

Figure 1

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Table 1

Drill Hole and Estimated Volume Data for Tailings Ponds

Pond	Drill Hole	Depth to Gravel, ft	Depth to Water, ft	Pond Area, sq yd	Pond Volume, cu yd	Estimated 1/ Tonnage
South	S-1	18	9			
	S-2	18.5	13.5	14,000	85,200	111,300
Middle	M-1	24	14.5			
	M-2	24	19	10,100	80,900	105,685
North	N-1	4	3	3,300	4,400	5,750
River S&N				13,000	8,800	11,495
Total					179,300	234,230

1/ Based on bulk density of 1.306 tons per cubic yard.

Table 2

Individual Samples Taken for Analysis

HRI Number	Pond	Hole	Depth, ft	Sample Weight, grams As-received	Dry	% Moisture
12896-1	Middle	1	0-5	2279	1692	25.8
-2	"	1	5-10	2369	1807	23.7
-3	"	1	10-15	1942	1480	23.8
-4	"	1	15-20	2610	1937	25.8
-5	"	1	20-24	1502	1124	25.2
-6	"	2	0-5	3202	2765	19.2
-7	"	2	5-10	2397	2072	13.6
-8	"	2	10-15	1324	1094	17.4
-9	"	2	15-20	2284	1732	24.2
-10	"	2	20-24	2504	1924	23.2
-11	South	1	0-5	1638	1261	23.0
-12	"	1	5-10	2595	1921	26.0
-13	"	1	10-15	2945	2265	23.1
-14	"	1	15-18	2010	1913	4.8
-15	"	2	0-5	2006	1631	18.7
-16	"	2	5-10	2170	1587	26.9
-17	"	2	10-15	1843	1379	25.2
-18	"	2	15-18.5	2172	1582	27.2
-19	North	1	0-4	1188	818	31.1

ESTIMATED TONNAGE

Bulk density measurements were made on several individual samples. These measurements gave an average bulk density of 1.55 which would give a bulk weight of 1.306 tons per cubic yard for the average material in the ponds. Using this factor times the estimated volume would indicate that the ponds contain 234,230 tons of calcine on an as-is basis or using an average moisture content of 22.5 percent, the indicated dry tonnage would be 181,500 tons. Because the pond measurements were not based on an accurate survey, these tonnage figures should be considered to be estimates which are within a plus or minus 10 percent accuracy range.

We would also estimate that, of the material in the three major ponds, approximately 90 percent could be reclaimed without serious contamination from the pond dikes or bottoms.

SCREEN ANALYSES

Because of the fine size consist of the material, all screen analyses were run on a wet screening procedure using Tyler standard screens. Data for the nineteen samples are recorded in Table 3.

With the exception of sample 14 taken from the bottom of hole 1 in the south pond, and showing some contamination with wood chips and gravel, all of the samples were minus 8-mesh and predominantly minus 65-mesh. On an average, the samples taken contained over 35 percent by weight of minus 400-mesh material.

As would be expected from the natural classification which takes place in tailings ponds, the individual samples vary considerably in the amounts of minus 400-mesh material going from as little as 16 percent to as much as 85 percent minus 400-mesh.

Table 3 (1 of 2 pages)

Screen Analyses Data for HRI Samples 12896
Rico-Argentine

Particle Size, Mesh											
Minus	Plus	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
	8										
8	10		0.3	1.7	0.4	0.4		0.5	1.2	3.1	6.4
10	14		0.0	0.3	0.3	1.2		0.0	0.5	1.1	2.9
14	20		0.2	0.4	0.9	1.8	0.1	0.3	0.8	1.8	3.5
20	28		0.0	0.7	0.7	0.6	0.0	0.0	1.0	2.7	3.2
28	35	0.0	0.1	1.6	2.3	2.2	0.0	0.3	1.6	4.4	4.4
35	48	0.1	0.0	2.8	3.9	3.7	0.2	0.4	2.6	5.5	4.7
48	65	0.1	0.5	2.7	3.1	3.0	0.7	2.0	3.6	4.9	3.6
65	100	0.2	1.2	4.3	2.7	2.7	7.4	14.3	9.1	6.9	4.7
100	150	0.5	2.3	5.5	2.9	3.1	26.6	27.8	16.7	11.1	8.6
150	200	1.5	3.6	7.0	6.7	6.6	22.3	19.0	17.1	16.1	12.8
200	270	3.7	5.5	10.5	14.6	16.3	13.5	12.2	13.4	14.6	12.6
270	400	8.7	9.9	9.8	12.9	8.0	8.9	7.2	10.2	5.4	7.8
400		85.2	76.4	52.7	48.6	50.4	20.3	16.0	22.2	22.4	24.8

Table 3 (2 of 2 pages)

Particle Size, Mesh										
Minus	Plus	-11	-12	-13	-14[1/]	-15	-16	-17	-18	-19
	8				11.4					
8	10		0.9	4.1	0.9	0.2	0.5	1.5	2.0	0.2
10	14		0.2	1.1	1.3	0.0	0.2	0.4	0.2	0.0
14	20		0.2	1.0	1.3	0.1	0.1	0.2	0.2	0.3
20	28		0.1	0.9	1.2	0.0	0.2	0.3	0.1	0.1
28	35	0.0	0.2	0.8	1.4	0.1	0.2	0.3	0.2	0.2
35	48	0.2	0.3	1.0	1.7	0.1	0.4	0.5	0.4	0.4
48	65	0.4	0.8	1.5	2.0	0.7	0.7	1.0	0.7	0.8
65	100	2.0	4.1	5.2	4.7	3.4	2.9	4.0	2.3	2.1
100	150	7.8	8.7	13.4	9.6	12.7	7.2	11.0	6.4	6.6
150	200	13.4	10.7	17.9	11.1	20.1	10.4	16.2	10.9	9.0
200	270	13.1	11.5	14.9	9.3	15.9	11.4	15.1	12.6	12.6
270	400	11.7	11.3	11.7	8.2	12.9	12.3	13.8	14.5	14.9
400		51.4	51.0	26.5	35.9	33.8	53.5	35.7	49.5	52.8

1/ Contaminated with wood chips and some gravel.

CHEMICAL COMPOSITION

All of the samples taken were analyzed for total iron, total sulfur, sulfate sulfur, and acid insoluble material. In addition, four selected samples were submitted for emission spectrographic analysis to determine the occurrence of trace elements.

CHEMICAL ANALYSES

The chemical analyses are shown in Table 4. These data indicate that the material varies widely in composition. The individual 5-foot drill hole segments ran from a maximum iron content of 66.5 percent to a minimum of 36.5 percent. The acid insol varies from 7.9 percent to 32.4 percent and the total sulfur varies from 0.12 to 4.5 percent with the major portion of the sulfur being present as sulfate sulfur.

In general, the iron content is higher, and the acid insol and sulfur contents lower in the samples taken from the upper zones in each pond. This would imply that a higher grade material could be obtained in a reclaim operation by taking only the top half or top third of the impounded material.

Table 4

Chemical Analysis of Drill Hole Samples

Sample	Weight, %			
	Fe	S Total	S as $SO_4^=$	Acid Insol
12896-1	59.1	0.43	0.17	9.7
-2	59.5	0.28	0.11	10.7
-3	50.0	2.32	2.02	15.2
-4	43.9	3.09	2.71	15.7
-5	44.1	3.05	2.63	16.3
-6	66.5	0.16	0.08	7.9
-7	63.0	0.12	0.07	12.6
-8	48.1	1.16	0.60	20.9
-9	37.2	3.52	2.76	24.4
-10	36.5	2.75	2.21	28.5
-11	62.8	0.46	0.09	8.4
-12	62.1	0.35	0.04	9.6
-13	58.5	0.46	0.04	12.9
-14	39.0	0.90	0.22	32.4
-15	62.1	0.65	0.17	9.5
-16	60.4	0.35	0.10	9.3
-17	60.0	0.38	0.06	10.2
-18	57.9	0.98	0.09	11.9
-19	45.9	4.50	0.33	21.0

SPECTROGRAPHIC ANALYSES

Four of the samples taken during the sampling program were submitted for spectrographic analyses to check on trace element impurities that might be encountered in the iron calcines.

Data from this work are recorded in Table 5. These numbers are qual-semiquant emission spectrochemical analysis results. They are expressed as weight percentages, and are estimates only.

Table 5

Spectrochemical Analysis

Element Found	12896-4	12896-8	12896-13	12896-16
Iron	Major[1/]	Major	Major	Major
Silicon	10%	10	10	10
Aluminum	8	8	8	8
Calcium	3	2	1	1
Zinc	3	4	2	2
Lead	0.5	0.5	0.3	0.3
Manganese	0.3	0.3	0.2	0.1
Titanium	0.05	0.03	0.02	0.05
Molybdenum	0.05	0.05	0.05	0.05
Magnesium	0.1	0.07	0.05	0.05
Chromium	0.002	0.003	0.003	0.003
Silver	0.002	0.002	0.001	0.001
Nickel	0.002	0.002	0.001	0.001

1/ = concentration above 10%.

These data indicate the presence of zinc and lead in all four samples. There is no indication of arsenic, antimony, cadmium, or other potentially hazardous material in any of the samples.

POTENTIAL MARKETS

The sampling program has shown the calcines in the Rico tailings ponds to be a finely divided iron oxide containing appreciable quantites of sulfur, predominantly as sulfate sulfur, and minor quantities of zinc and lead.

The higher grade portions of the impounded material, i.e., the upper sections, are sufficiently high in iron oxide content and low enough in sulfur content to be considered as marketable material for the cement industry. The usefulness of this material would depend almost entirely on the delivered cost at the cement plant as compared with other available sources of iron.

The absence of hazardous trace elements should make the Rico tailings a suitable source material for the manufacture of iron chemicals either for water treatment or agricultural use. Here again, its usefulness would largely depend on the delivered product price.